Floor-Cushion and Method of Evaluation Thereof

Field of the Invention

The current invention relates to a floor-cushion that enables a person who sits thereon to correct the sitter's posture.

Description of the Related Art

Even today, when Western-style architecture is prevalent in Japan, the daily lives of Japanese people~~'s~~ ~~daily lives~~ generally include time sitting on tatami-mat floors. As a result, their posture becomes poor even when they sit on cushions placed on the (tatami-mat) floor. Accordingly, a number of conventional types of floor-cushions that serve to help keep a sitter's spine properly aligned, to correct the sitter's posture, and to help the sitter to maintain a straight posture have been proposed from the viewpoint of ergonomics.

Most of such conventional floor-cushions have a structure such that ~~the~~ a part that supports the buttocks— on which a large load is applied — is (1) raised, and (2) made of a relatively hard material (such as hard urethane foam or hard sponge, which is harder than, and about twice as thick as, the elastic urethane foam that is generally used as a filler of a floor-cushion). For example, the floor-cushions disclosed in Japanese Published Unexamined Utility Model Application No. S60-97062 (page 1) ~~Patent Document 1~~ and Japanese Published Unexamined Patent Application No. H11-155696 (pages 2–3) ~~Patent Document 2~~ are devised such that they are used to place the sitter's buttocks on the part composed of hard material, in order to prevent the sitter's pelvis from slanting backwards.

~~Patent Document 1: Japanese Published Unexamined Utility Model Application No. S60-97062 (page 1)~~

~~Patent Document 2: Japanese Published Unexamined Patent Application No. H11-155696~~

~~(pages 2-3)~~

However, cushions made by the above-mentioned conventional technique have the following disadvantages/problems: (1) if a person sits on such a floor-cushion for a long time, muscular fatigue results due to resiliency of the cushion's hard part, which supports the buttocks; and (2) the effective area of the cushion's hard part that is to sustain the load from the buttocks becomes small, particularly if the form of the hard part does not fit the buttocks, and, as a result, such a floor-cushion does not support the buttocks properly over an extended period of time.

The ~~current~~ present invention has been made in view of the above problems, and it incorporates research results based on data that we obtained through our extensive ergonomic experiments. The purpose of the current invention is to provide (1) a floor-cushion that is constituted in such a way that (a) its rear portion, on which the sitter's buttocks are placed, is thicker than its front portion, on which the sitter's legs are crossed or placed, in order that the rear portion that supports the buttocks is higher than the front side, so that the sitter can comfortably maintain correct posture of the spine (i.e., a proper S-curve of the spine), and (b) ~~said~~ the floor-cushion has a large area for supporting the buttocks, which gives ~~said~~ the floor-cushion such variability in its form that it fits the ~~forms~~ and ~~structures~~ of different individuals' buttocks, enabling the sitting load to be uniformly applied across the broad area of the buttocks, so that muscle fatigue rarely results, even when the person sits for a long time; and (2) methods of evaluating such a floor-cushion.

Disclosure of the Invention

To achieve the above goals, the invention ~~described in Claim 1~~ relates to a floor-cushion, covered with a floor-cushion bag~~, wherein~~.

~~(1) t~~The floor-cushion is divided into a rear portion that supports the buttocks and a front portion on which the sitter's legs are crossed or placed~~, and~~. The floor-cushion bag is

correspondingly divided into rear and front portions. ~~;~~

~~(2) t~~The buttocks-supporting portion is filled with cork chips. ~~;~~

~~(3) t~~The inside of the legs-crossed portion consists of two soft-foam resin layers that enwrap a hard-foam resin layer, thus creating a three-layered structure for the legs-crossed portion. ~~; and~~

~~(4) t~~The buttocks-supporting portion is thicker than the legs-crossed portion, and it slants downward toward the legs-crossed portion, so that anteversion of the pelvis is promoted.

Another aspect of ~~T~~the invention ~~described in Claim 2~~ relates to a floor-cushion ~~as cited in Claim 1,~~ wherein ~~said~~ the hard-foam resin layer of the legs-crossed portion is a plate-like, hard-polyurethane layer, and ~~said~~ the surrounding soft-foam resin is a soft polyester foam.

~~The~~ Another aspect of the invention ~~described in Claim 3~~ relates to a floor-cushion ~~as cited in Claim 1 or Claim 2,~~ wherein the anteversion angle of the top of ~~said~~ the buttocks-supporting portion is 5 degrees to 30 degrees on average.

Another aspect of the ~~The~~ invention ~~described in Claim 4~~ relates to a floor-cushion ~~as cited in any of Claims 1–3,~~ wherein ~~said~~ the cork chips occupy 20%–25% of the space of the buttocks-supporting portion.

Another aspect of the ~~The~~ invention ~~described in Claim 5~~ relates to a floor-cushion ~~as cited in any of Claims 1–4,~~ wherein the shape of ~~said~~ the floor-cushion is basically heart-like, with the wider, front area of the "heart" being the thick, buttocks-supporting portion, while the narrower, rear area of the "heart" is the legs-crossed portion, and with the area occupied by a floor-cushion intended for females being larger than that of a floor cushion intended for males.

In a method aspect of the ~~The~~ invention ~~described in Claim 6 is a~~ method ~~method~~ of evaluating a floor-cushion ~~as cited in any of Claims 1–5, wherein said evaluation~~ is made based on:

(1) a short-time sitting simulation that includes (i) measurement of the pelvic-inclination angle, (ii) VTR filming thereof, and (iii) the sitter's evaluation of his/her sensory experience of sitting comfort,

(2) a long-time sitting simulation that includes (i) measurement of variations in a sitter's pelvic-inclination angle, (ii) VTR filming of ~~said~~ the sitting, (iii) frequency analysis of the pelvic-inclination angles as determined in (i) above, and (iv) the sitter's evaluation of his/her sensory experience of a feeling of fatigue at preselected places in the body; as well as

(3) information obtained via questionnaires completed by various people, including Europeans and Americans.

Another aspect of the ~~The~~ invention ~~described in Claim 7~~ relates to a method of evaluating a floor-cushion, ~~as cited in Claim 6,~~ wherein ~~said~~ the measurement of the pelvic-inclination angle is done in the following way: each of a predetermined number of test subjects wears a pelvic-inclination-angle sensor belt, whereby each person's pelvic-inclination angle is measured while the person is sitting on a commercially available floor-cushion and while sitting on the floor-cushion of this invention.

Another aspect of the ~~The~~ invention ~~described in Claim 8~~ relates to a method of evaluating a floor-cushion, ~~as cited in Claim 6,~~ wherein after ~~said~~ the sensory-experience evaluation of sitting comfort is done in such a way that there is created a radar chart that shows extracted factors obtained by processing the collected data regarding assessment items — using the ANOVA (analysis of variance) method — so that the subjective assessments made by the test subjects during ~~said~~ the sensory–experience evaluations can be utilized.

Another aspect of the ~~The~~ invention ~~described in Claim 9~~ relates to a method of evaluating a floor-cushion, ~~as cited in Claim 6,~~ wherein ~~said~~ the pelvic-inclination angle in ~~said~~ the long-time sitting is measured three times, i.e., at the start of sitting, 20 minutes after the start of sitting, and 40 minutes after the start of sitting, for the aforementioned predetermined parts of the sitter's

body.

Another aspect of the ~~The~~ invention ~~described in Claim 10~~ relates to a method of evaluating a floor-cushion, ~~as cited in any one of Claims 6-9,~~ wherein ~~said~~ the pelvic-inclination angle is evaluated in such a way that the pelvic-inclination angle data is subjected to a frequency analysis, using a time-series-analysis model formula.

Brief Descriptions of the Drawings

Figure 1 shows a floor-cushion in one embodiment of the ~~current~~ present invention; (a) is an entire perspective view, and (b) is a side cross-sectional view.

Figure 2 is contains plane views showing two types (Type-A and Type-B) of the floor-cushion shown in Figure 1.

Figure 3 shows typical postures using a floor-cushion: (a) using the floor-cushion shown in Figure 1; (b) using a conventional one.

Figure 4 compares the pelvic-inclination angles when using the floor-cushion shown in Figure 1 and when using a conventional one.

Figure 5 is a radar chart that compares the results of sensory-experience evaluations of two types (Type A and Type B) of the floor cushion shown in Figure 1 with the results of such evaluations of a conventional floor cushion.

Figure 6 shows the results of one man's and one woman's sensory-experience evaluations of their comfort while stretching their backs while sitting on the two types (Type A and Type B) of the floor-cushion shown in Figure 1, and while sitting on a conventional floor-cushion.

Figure 7 shows the results of one man's and one woman's sensory-experience evaluations of their sitting comfort while sitting on the floor-cushion shown in Figure 1, and while sitting on a conventional floor-cushion.

Figure 8 compares typical variations in a test subject's pelvic-inclination angle

(forward/backward) and changes in posture over a 40-minute period while using the floor-cushion shown in Figure 1 and while using a conventional cushion.

Figure 9 compares the average variation in younger test subjects pelvic-inclination angle (forward/backward) over a 40-minute period while using the floor-cushion shown in Figure 1 and while using a conventional cushion.

Figure 10 compares the frequency-analysis results of a test subject's pelvic-inclination angle's (forward/backward) vibration, at 5 minutes and 15 minutes after the start of sitting, while using the floor-cushion shown in Figure 1 and while using a conventional cushion.

Figure 11 compares the results of a sensory-experience evaluation of feeling of fatigue at various places of test subjects body while using the floor-cushion shown in Figure 1 (referred to as "ergo" in Figure 11) and a conventional cushion (referred to as "normal" in the Figure.)"

Figure 12 shows Westerners' subjective evaluations of sitting on the floor-cushion shown in Figure 1.

Descriptions of the Preferred Embodiments

Embodiments of the current invention are explained in detail below, with reference to the drawings.

As shown in Figure 1 [the entire perspective view in Figure 1(a); the side cross-sectional view in Figure 1(b)], the floor-cushion 1 of the current invention is divided into a buttocks-supporting portion 1A and a legs-crossed portion 1B.

The buttocks-supporting portion 1A is filled with cork chips 2, which are either (a) directly placed therein, or (b) placed inside an inner bag that is placed therein, while the legs-crossed portion 1B has a three-layered structure consisting of a hard-foam resin layer 3 and two soft-foam resin layers 4 that surround the hard-foam resin layer 3.

As a result, the buttocks-supporting portion 1A of the floor-cushion of the current invention

is thicker than the legs-crossed portion 1B, so that the buttocks-supporting portion 1A inclines toward the legs-crossed portion 1B in such a way that forward inclination of the pelvis is promoted. In this embodiment, the average thickness of the buttocks-supporting portion 1A is 6 cm.

In addition, the material of the hard-foam resin layer 3 is a plate-like hard-polyurethane layer, while the material of the soft-foam resin layer 4 is a soft-foam polyester. It is desirable that the forward-inclination angle of the top surface of the buttocks-supporting portion 1A be 5 degrees–30 degrees on average. Further, the cork chips 2 in the buttocks-supporting portion should occupy 20%–25% of the inner volume of the buttocks-supporting portion, and the diameter of a cork chip should be about 0.2 cm on average. (Here, natural cork chips are used; however, any one of a variety of other substitute materials — such as artificial cork that has been developed recently — can of course be used.)

In Figure 2, drawings A and B show two types of floor cushions: Type-A, which is intended for a woman, and Type B, which is intended for a man.

In designing the shape and dimensions of these floor-cushions, such differences due to gender have been taken into consideration, in that most females sit with their legs folded sideways or with each of their legs folded to its respective outside of the buttocks, whereas most males sit with their legs crossed.

Next are presented an analysis and verification of the performance of floor-cushions having the above-mentioned configuration.

When a person sits on a conventional floor-cushion, his/her pelvis tends to tilt backward, which worsens scoliokyphosis and likely causes crookback. As shown in Figure 3(b), when a person sits on a conventional floor-cushion for an extended period of time, the person's center-of-gravity line moves forward significantly from the spine, which increases the load on the vertebral bodies, and can induce muscular-skeletal disorder such as lubber backache or

compression in the abdomen.

To solve these problems, the rear portion of the floor-cushion of the current invention has a thick, inclined part (the brand name of which is Pelvic Support) that promotes the forward inclination of a sitter's pelvis, as shown in Figure 3(a).

A series of simulations using test subjects is done as follows:

First, while a test subject sits on the floor-cushion for a short time, the person's pelvic-inclination angle is measured, the scene is video-recorded, and the test subject's evaluation regarding his/her sensory experience is recorded.

Second, while a test subject sits for a long time on a floor-cushion that has been placed on a tatami-mat that is used to recreate an actual Japanese daily-life sitting environment, we (1) conduct research regarding the degree of fatigue felt at different parts of the sitter's body and (2) gather data regarding the variations of the sitter's pelvic-inclination angle.

We then analyze the results of (1) and (2) by using an AR (auto-regressive) model of time-series analysis, and thereby we can perform (3) a product-merchandising simulation using the newly developed floor-cushion (whose brand name is Ergo Zabuton), and (4) verification of the performance of the floor-cushion.

These evaluation and verification procedures are described in detail below.

1. Evaluation of the Effects of Short-Time Sitting

1.1 Research Methodology

To determine the effectiveness of the Pelvic Support part of the floor-cushion, variations in the forward-/backward-inclination angle (pitch angle) of a sitter's pelvis were measured, using a device (sensor) that had been developed by the present applicant for measuring ~~said~~ the pelvic-inclination angle.

On anatomical grounds, a person's pelvic-inclination angle indicates the load applied on the person's lumbar portion, such that (1) the load on one's backbone is small when the pelvis is

maintained slightly forwardly inclined or without being inclined either forward or backward, and (2) scoliokyphosis is worsened when the pelvis is inclined backward.

A comparison was made of the inclination angle of the pelvis when a person was sitting on (a) the floor-cushion 1 of the current invention, and (b) a commercially available floor-cushion [550 mm (w) x 590 mm (h); 55% polyester, 45% cotton].

1.1.1 First, an inclination-angle sensor was placed, using a belt, on a test subject in such a way that the sensor would be positioned on the upper portion of his/her iliac bone.

The inclination-angle sensor that was used was small (36 mm by 36 mm) and lightweight (50 g). Its measurement error is ± 0.5 degrees, and the measured data was A/D converted and recorded in a PC. Simultaneously, changes in the posture of the test subject were video-recorded from one side, using a digital video camera.

The sampling interval for measuring the inclination angle of the pelvis was set at 1 second; the output (value) of the sensor when the test subject was standing was set to a reference value of 0 degrees, and the backward inclination was set as positive. The test subjects were adults — 1 man and 1 woman — of average height (male: 170 cm; female: 160 cm) (see Figure 4).

1.1.2 In addition, a sensory-experience test regarding comfort during short-time sitting was made on test subjects who consisted of twenty (20) university students aged in their 20s (10 males whose average age was 23.4 years; 10 females whose average age was 25.2 years).

As a questionnaire, the "Seating Sensory Check Sheet" (Japanese brand name "Zakan Chekku Shiito"), produced by Zaidan-Hojin Shisei-Kenkyujo (Posture Research Foundation), was adopted and then further improved so that it might be used in evaluating a floor-cushion.

A total of 36 inquiry items were prepared, including (1) whether the size of the floor-cushion felt good, (2) whether the floor-cushion felt comfortable for one's buttocks, (3) whether the floor-cushion felt comfortable for one's thighs and lower legs, (4) whether one felt that one could easily stretch one's back while sitting on the floor -cushion, and (5) whether one felt that

one was sliding down and forward while sitting on the floor-cushion.

The inquiry items were evaluated on a scale of five (5) grades.

1.2 Research Results

1.2.1 Results of measurement of inclination angle of the pelvis

When a test subject's posture changed from standing to sitting with his/her legs crossed, the pelvis inclined backward when both the floor-cushion 1 (Type-A) and the conventional floor-cushion was used.

However, when the floor-cushion 1 (Type-A) was used, the backward inclination of the pelvis was about 10 degrees less than that when the conventional floor-cushion was used.

In addition, as shown in Figure 3, VTR monitoring revealed that the back of the test subject curved backward when the conventional floor-cushion was used [see Figure 3(b)], while the back stretched upward when the floor-cushion 1 (Type-A) was used.

1.2.2 Results of sensory-experience evaluations of comfort

The tabulated results of the test subjects' responses that were recorded on the questionnaire sheets were examined using factor analysis, by using SPSS 10.0J for Windows® (calculation software used for ANOVA (analysis of variance)).

As a result, 11 factors were extracted from the 36 evaluation items (cumulative contribution ratio: 70.4%). The factors were defined as follows.

Factor 1 was defined as "factor relating to the hardness of the buttocks-supporting portion of the cushion and how easily one could stretch one's back."

Factor 2 was defined as "factor relating to sitting comfort,"

Factor 3 was defined as "factor relating to the test subject's feeling of "having gotten clung" by the cushion, i.e., that the floor-cushion was clinging to his/her buttocks and/or legs.

Then, for the purpose of examining the influence on each factor of the difference in the type of floor-cushion being used, the average scores for each factor were calculated and presented

on a radar chart (see Figure 5).

In Figure 5, the farther a factor is plotted from the center, the higher the score of that factor as to the type of floor-cushion used.

In addition, by applying a multiple comparison test as to the type of floor-cushion, it was discovered that both Type A and Type B of the current invention's floor-cushion were statistically significantly different from the conventional floor-cushion in regard to both Factor 1 and Factor 7.

In regard to Factor 1, the ANOVA results was: $F(2, 57) = 69.73$, $p < 0.0001$), for the hypotheses "Conventional cushion < Type A," and "Conventional cushion < Type B."

In regard to Factor 7, which relates to the size of the floor-cushion, the ANOVA result was: $F(2, 57) = 13.85$, $p < 0.0001$); for the hypotheses "Type-B < conventional cushion < Type-A."

Furthermore, focusing on the subjective evaluation responses relating to the sensory-experience evaluation concerning (1) "ease of stretching the back" (which means how easy the test subject feels when he/she stretches his/her back) which relates to Factor 1, and (2) "overall sitting comfort" which relates to Factor 2, we conducted a two-way layout ANOVA with a chi-square test as to type of floor-cushion and gender.

In regard to "ease of stretching the back," only a weak significance in difference (ANOVA; $F(1, 54) = 3.851$, $p = 0.055$) was found as to gender, while a significant difference was found at a confidence level of 1% as to type of floor-cushion: both Type-A and Type-B had a higher score than the conventional floor-cushion did ($p < 0.01$); as a result, the men's scores tended to be higher than those of the women. (See "Sensory-Experience Test Results relating to Ease of Stretching the Back (average of male and female values ± standard deviation)" in Figure 6.)

Relating to "overall sitting comfort," as is shown in Figure 7, no significant difference was found as to gender, while as to floor-cushion, it was found that, at a confidence level of 1%, Type-A provided the best sitting comfort ($p < 0.01$).

2. Evaluation of the Effects of Long-Time Sitting

The conventional floor-cushion and the Type-A floor-cushion 1 of the current invention will now be compared in regard to long-time sitting.

2.1 Research Methodology

We examined how the human body is affected when a test subject sits on a floor-cushion for a long time. To conduct this research, as is mentioned above, we actually created a typical Japanese floor-seating environment, using a tatami mat. We then measured and recorded changes in the inclination angle of the pelvis while a test-subject sat for 40 minutes on either (a) the Type-A floor-cushion 1 or (b) a conventional floor-cushion. Simultaneously, change of the posture of the test-subject was video-recorded from one side. In addition, the degree of fatigue felt by a test-subject at different parts of his/her body was evaluated — using a questionnaire given to him/her— at three times: (1) at the start of sitting, (2) 20 minutes after the start of sitting, and (3) 40 minutes after the start of sitting. A total of 14 parts of a subject's body were designated as places at which the degree of feeling of fatigue would be measured: head, neck, shoulders, upper arms, elbows, forearms, abdomen, upper back, lumbar portion, buttocks, thighs, knees, shanks, and feet.

Evaluations were made using a scale of seven (7) grades, and measurement was done on a randomized basis, taking a sufficient amount of time.

In this case, the test subjects were 7 men: 6 university students (average age: 24) and 1 university faculty member (age: 65).

As a research task, the test subjects watched a video movie while sitting on a floor-cushion in a crossed-leg posture. The sitting time was limited to 20 minutes for the 65-year-old man, because of our concern that it would be too difficult for him to continue sitting in a cross-legged posture for a longer time.

2.2 Research Results

2.2.1 Variations in inclination angle of the pelvis

Our examination of the correlation between the pelvic-inclination-angle data and posture changes as recorded via a VTR revealed that when the pelvis inclines backward the lumbar portion is bent forward, and that, when the pelvis approaches an upright position (i.e., the inclination angle is at the reference value of 0 degrees), the lumbar portion stretches into its normal position.

Figure 8 shows the results of a collation (i.e., matching) between (1) time-dependent variations in the forward-/backward-inclination angle of the pelvis and (2) changes in posture, both when the Type-A floor-cushion 1 of the invention was used and when the conventional floor-cushion was used. As a test subject, there was selected a 22-year-old male who is of a stable posture and is able to continue to sit for a comparatively long time.

In both cases, the pelvis gradually inclined backward as time passed. However, when the conventional floor-cushion was used the pelvis inclined backward within a range of 23 degrees–29 degrees, while when the Type-A floor-cushion 1 was used the backward-inclination angle of the pelvis was in the range of 22 degrees–24 degrees, which is a smaller range than that when the conventional floor-cushion was used.

Monitoring of the changes in the posture of the same test subject revealed that he changed his posture twice, i.e., resettling himself (10 minutes and 30 minutes after the start of sitting) when using the conventional floor-cushion, whereas his posture was stable (i.e., did not change) when using the Type-A floor-cushion 1.

Then, as is shown in Figure 9, all of the sampling data (every 5 minutes) of the forward-/backward-inclination angles of the pelvis of the younger test subjects were averaged, whereby omitted are rapidly changing data portions collated with (intentional) posture change (resettling, etc) of the test subjects.

The results revealed that: (1) when a test subject sits on the Type-A floor-cushion 1 for 40

minutes, the backward inclination angle of the pelvis is less — by 5 degrees on average — than that when the subject sits on the conventional floor-cushion, and (2) therefore the lumbar portion can be stretched more easily when the Type-A floor-cushion 1 is used.

Also, it was found that the same pattern — the pelvis gradually inclining more backward, and then, after a while, inclining backwards to a lesser degree — was repeated through the 40 minutes of sitting.

The posture-variation pattern arose about 5 minutes after the start of sitting when the conventional floor-cushion was used, while it did not arise until about 15 minutes after the start of sitting when the Type-A floor-cushion 1 was used.

Furthermore, a two-way layout ANOVA of the pelvic-inclination angle — as to the type of floor-cushion and the (elapsed) time (eight time points, each 5 minutes apart) — shows that there was a significant difference in the effects of the two types of floor-cushions. Significance was confirmed in the difference between the average scores for the Type-A floor-cushion 1 and the conventional floor-cushion at different time points (ANOVA: $F(1, 8) = 5.34$, $p = 0.049$).

As mentioned above, we concluded that variations in the pelvic-inclination angle between the Type-A floor-cushion 1 and the conventional floor-cushion were such that the backward inclination of the pelvis was less (better) when the conventional floor-cushion was used than when the conventional floor-cushion was used.

2.2.2 Frequency analysis of variations in the pelvic-inclination angle

The pelvic-inclination angle data was frequency-analyzed using an AR model, which is one type of time-series analysis model.

Figure 10 shows results of frequency analysis of data obtained at 5 minutes and 15 minutes after the start of sitting, when the test subject was the 65-year-old male. When he used the conventional floor-cushion, at 5 minutes there arose large, high-frequency-spectrum components, which means fast motion. Furthermore, the amplitude (power) of the vibration when the

conventional floor-cushion was used was by far larger overall than when the Type-A floor cushion 1 was used. (Note that ordinal scale of conventional floor-cushion differs from that of Type-A floor-cushion 1.)

This points out that it was difficult for a sitter to maintain a stable sitting position while using the conventional floor-cushion. Such frequent changes of posture can be considered as actions to alleviate (a) lower-leg numbness, which is caused by crossing the legs, and (b) an accumulated feeling of fatigue at various parts of the body, such as the lumbar portion, caused by sitting. Therefore, we concluded that the floor-cushion of the current invention has the effect of delaying both lower-leg numbness and fatigue at various parts of the body.

2.2.3 Degree of feeling of fatigue at various parts of the body

Sensory-experience-evaluation data was collected by using the aforementioned seven-grade scale, at the time of the start of sitting, 20 minutes after sitting started, and 40 minutes after sitting started. Then, (after each data item had been converted into an appropriate ordered numerical score) the data was accumulated for the 6 younger test subjects in regard to various parts of the body. The resulting scores relating to a feeling of fatigue are summarized in Figure 11.

As is shown in Figure 11, the degree of feeling of fatigue was generally less when the Type-A floor-cushion 1 (referred to as "ergo" in Figure 11) was used than when the conventional floor-cushion (referred to as "conventional" in Figure 11) was used. Then, a two-way layout ANOVA regarding the accumulated scores concerning feeling of fatigue was performed as to the types of floor-cushion (Type-A of the current invention and conventional) and elapsed time (three time points: starting time, 20 minutes thereafter, and 40 minutes after the start of sitting.)

The results reveal that the feeling of fatigue significantly increased as time passed ($p < 0.05$). Also, as to the type of floor-cushion, the feeling of fatigue at the head, neck, shoulders, and waist was significantly less when the Type-A floor-cushion 1 was used than when the

conventional floor-cushion was used.

From the above it can be said that, although a time-dependent feeling of fatigue is not fully eliminated by using the floor-cushion of the current invention, the feeling of fatigue of the body as a whole is less than that when a conventional floor-cushion is used, and that, in particular, the feeling of fatigue at the lumbar portion is relieved by using the floor-cushion of the current invention.

3. Results of Research Involving European and American Test Subjects

At the International Conference of Ergonomics WWDU2002 held in Germany in May 2002, the applicant had an opportunity to demonstrate the floor-cushion 1 of the prevent invention. Figure 12 shows the averaged results of European and American sitters' five-level subjective evaluations — where "5" is the best score — of the floor-cushion 1 with regard to the following three items: (1) "Is the size of the cushion appropriate? – Suitability of size," (2) "Can the back be easily straightened? – Ease of straightening the back," and (3) "Is the cushion comfortable to sit on? – Sitting comfort."

Positive results were obtained, showing that the cushion's size was scored 3+ (more than satisfactory), while the scores regarding both ease of straightening the back and sitting comfort were 4 or higher.

When the participants were asked how they would use this floor-cushion 1 in a European or American living environment, their responses suggested that they might using the floor-cushion 1 to sit on the floor while in their home or office while working on a PC, or while reading or writing. Such comments suggest that there is a hidden or unexpected potential demand for the floor-cushion of the current invention.

In summary, as is mentioned above, the present applicant has developed a novel floor-cushion incorporating Pelvic Support, for the purpose of preventing kyphosis caused by the backward inclination of the pelvis that would occur while sitting "flatly," i.e., in a position such

that one's buttocks are not raised slightly. The present applicant has measured the inclination angles of the pelvises of various sitters (test subjects), has analyzed the sitters' actions as recorded by a VTR, and has obtained, by sensory-experience reports, the sitters' subjective evaluations of both sitting comfort and feeling of fatigue.

The research conducted has revealed that the floor-cushion 1 of the current invention has advantages over a conventional floor-cushion in regard to the following factors.

(1) Inclination angle of the pelvis: The backward inclination of the pelvis is reduced by 5 degrees–10 degrees, so that the back is more easily stretched upward and the sitter's posture is stabilized.

(2) Sitter's action: Sitting-resultant actions, such as changing position (resettling) occur less often, and sitters are more easily able to maintain a stable posture.

(3) Sensory-experience evaluations: Higher scores were given regarding "ease of stretching the back" and "overall sitting comfort."

(4) Feeling of fatigue: The scores were lower (better) for various parts of body in general, and were significantly low in regard to the head, neck, and lumbar portion, in particular.

(5) Evaluations by Europeans and Americans: High scores were given regarding "ease of stretching the back" and "overall sitting comfort."

From the above-mentioned results, we can expect that the floor-cushion 1 of the current invention is a useful tool that supports a traditional floor-sitting posture and that promotes healthy and comfortable sitting.

Also, the above-mentioned results of simulations and product-evaluation methods can be merchandized all together in the form of software for designing and manufacturing a commercial product that is named Ergo-Zabuton, as a part of an entire floor-cushion production system. Also, the above-mentioned results are very useful as sales-promotion data.

Industrial Applicability

As described above, the current invention is a floor-cushion whose inside is divided into a buttocks-supporting portion and a legs-crossed portion, with the buttocks-supporting portion filled with cork chips, while in the legs-crossed portion a hard-foam resin layer is enwrapped by two soft-foam resin layers, so that the legs-crossed portion has a three-layer structure. In addition, the rear end of the floor-cushion is made thicker in such a manner that the buttocks-supporting portion inclines downward toward the legs-crossed portion, so as to promote forward inclination of the pelvis, so that a sitter's backbone can be maintained in the proper posture.

In addition, the rear portion of the floor-cushion is made thicker in such a manner that the portion contacting the buttocks is higher than the cushion's front, legs-crossed portion.

Furthermore, the elasticity of the cork chips enables the floor-cushion's shape to be varied so as to fit the shape and structure of the buttocks of each individual, so that the sitting load is evenly distributed across a wide area of the buttocks. Therefore, the current invention has such an excellent effect that muscle fatigue is minimized even during long-time sitting.

Abstract

There is provided a floor-cushion whose structure is such that it (a) enables a person sitting on it to maintain his/her backbone in an appropriate posture, while (b) causing little fatigue in the sitter's muscles, even during long-time sitting. The inside of said floor-cushion (1) is divided into a buttocks-supporting portion (1A) and a legs-crossed portion (1B). The buttocks-supporting portion is filled with cork chips (2), while in the legs-crossed portion a hard-foam resin layer (3) is enwrapped by two soft-foam resin layers (4), so that the legs-crossed portion has a three-layer structure. The buttocks-supporting portion is made thicker than the legs-crossed portion, so that the buttocks-supporting portion inclines downward toward the legs-crossed portion, so as to promote forward inclination of the pelvis.